ECOLOGICAL NOTES ON THE TREES OF THE BOTANICAL GARDEN AT NAPLES.

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(WITH FOUR FIGURES)

A VIEW of the country about the bay of Naples in the spring gives very little idea of the luxuriance of the vegetation of which the land is capable. The only trees left standing are the stone pines, and these are pruned to the very crown for firewood, leaving only the upper cone-bearing branches, which produce the seed the people so much enjoy. The ilex oaks never get much higher than the rosemary and the heather, and all are lopped for fagots, unless they have selected inaccessible rock niches to grow in. To be sure, the peasants cultivate the black poplars, but only for use in their vineyards. The living trees make the vine posts, and the cut branches of their pollarded trunks are used for stakes and cross-bars for the clinging tendrils. Every winter the shoots are cut back from the top of the trunk, and every summer a small new crop grows from the mutilated top, making a light shade from the hot rays of the sun.

It is a singularly treeless region. The impression of the country in the clear atmosphere is much like that of the foothills east of the Cascades in the rainless regions of Washington and Oregon. There is the same soft gray color on the hills, that readily changes under the influence of the sun and the clouds, and the gray artemisias on the rocks help to make the picture the same. Yet this land, so like our own desert in color and absence of trees, is very different in its power to produce the fruits of the soil. There is water to be had from the clouds in abundance at all seasons, except in the three summer months, and the apparent barrenness is only the result of the kind of crops the peasant plants, and the way he has dealt with the native trees. Every available spot is devoted to the cultivation of the grape, and the land is terraced for vines up the slopes of the old volcanic cones and sometimes down to the very depths of their worn-

out craters. All the wild shrubs go into the fire to cook the daily meal. The succulent cactus and the spiny century plant, fugitives from America, are protected from the hacking of the peasant's knife, and having escaped have made themselves perfectly at home here.

It is only in the gardens that one sees trees, and there one is struck by the cosmopolitan mixture. There are few natives of Italy, but many foreigners. The ilex oak is the hardiest of the natives, and the tree most often used along the avenues in the parks, but, with this exception and the cypresses and Judas trees, the gardeners have gone to other countries to get trees for adornment. A critical eye is at once struck by the multitude of plant types represented, and the marvel grows when one considers the exact habitat of the foreigners and the perfection of their development under cultivation here in Italy. This Mediterranean region is the home of the *Hartlaubgehölze* of the warm temperate zone, with the ilex oak, European olive, and classic laurel among the best-known and most representative examples; but there are Australian trees here from within the tropics; trees from the cold northern forests of our own land; some from the deserts of Africa; and others from the mountains of Asia. They stand for types of all the ecological regions of SCHIMPER, except the Arctic and the ever rainy forests of the tropics. The soil and the climatic conditions seem remarkably congenial to these strangers, and they appear to grow as well as under the conditions native to them.

The Royal Botanical Garden of Naples is an admirable place for the study of diverse types of trees, for it furnishes many species and these are growing almost in a state of nature. The funds of the garden have been for many years too small to give them much care beyond that which locks the gates and gives them the chance to live. The whole yearly allowance for the support of the gardens, the greenhouses, the library, and all the force employed from the director to the gatekeeper is 7000 lire (about $1400). Some years ago there was sometimes a little to be expected from the city of Naples, but the sum has been for many years too inadequate for what we should consider the actual needs of a botanical garden. One resident spoke of it as "a ruin twenty years ago," but the very ruin is of deepest interest to a student of ecology. It shows forms from many climates mingling

and growing freely under conditions unnatural to them at home, and the marvel is that they find it so easy to do it.

It is instructive to run over the climatic conditions that exist here and contrast them with what can be gathered concerning those of other lands which have representatives here. Naples lies in the warm temperature region of winter rains. The latitude is 40° 52′, the longitude 14° 15′ east. The garden is a short distance from the sea, from 31.30 to 44.50^{m} above it, and lies on a slope that looks southeast to Vesuvius. Back of it and protecting it from the north winds, rises the hill of Capodimonte, on which is an observatory from which the meteorological observations were taken which are given in the table below. Since the hill is much higher than the garden and more exposed, the conditions are not quite those which hold in the garden itself, 103^{m} below. In an account of the garden published in 1867 by PASQUALE, a former director, some of the climatic conditions are discussed. In 1846 there was a summary made of the observations of temperature for twenty-four years. The medium temperature for these years was 15.66° C. The highest temperature recorded was for July 17, 1841, 39° C.; the lowest was February 21, 1845, −5.8° C. The period of greatest heat succeeds July 25, and that of greatest cold January 24. Specially cold nights are recorded, when the temperature sank to −7° C. and −8° C. Such periods of extreme cold are rare, occurring perhaps only once in ten years. The thermometer seldom sinks to the freezing-point, and hoar frosts are most unusual. The table given below is for the year 1902, and is taken from the monthly reports published by the observatory of Capodimonte, 149^{m} above sea-level.

The rain falls for the most part in the winter, but the amount that falls in special months varies from year to year. In general it is greatest from October to February, and least in June, July, and August; in 1902 sinking to zero in July.

SCHIMPER divides the globe into regions according to the relative amounts of rain during the year and the seasons in which it falls. If we follow this classification in arranging the plants of the garden, grouping them with the countries where they are native, we shall be able to make some interesting comparisons.

METEOROLOGICAL OBSERVATIONS TAKEN AT CAPODIMONTE FOR THE YEAR 1902

Months	Average of maximum daily temperature °C.	Average of minimum daily temperature °C.	Average of relative humidity at 3 P. M.	Total rainfall in mm.	Evaporation in the 24 hours in mm.	Maximum temperature °C.	Minimum temperature °C.
January	11.88	7.23	62.8	65.6	44.8	....	0.8°
February	13.32	8.66	76.6	103.4	34.1	16.9°	4.1
March	14.12	8.19	68.7	76.1	56.9	17.5	2.4
April	18.79	12.26	71.6	65.8	55.6	21.7	6.5
May	18.35	11.42	55.3	80.2	70.3	26.3	8.0
June	23.99	16.59	55.0	8.0	107.0	29.7	11.0
July	28.73	20.50	61.1	0.0	137.7	31.3	17.8
August	28.66	20.29	62.7	9.0	110.5	33.6	16.0
September	26.14	18.98	64.3	82.5	102.1	32	13.6
October	20.34	15.41	78.7	171.7	59.8	26.3	10.2
November	14.98	9.80	70.8	157.8	47.0	18.5	5.3
December	11.23	6.91	67.8	66.9	46.3	....	2.1
				887.0			

1. *The temperate regions of winter rains and summer drouths.*—The countries included are Italy and the other lands bordering on the Mediterranean, the coast of southern California, and the coast region of southwestern Australia. These regions are in about the same latitude, and they all have an annual rainfall of 60–130^{cm}. Representatives in the garden are many, the ones selected for our purpose being as follows: ITALY: Quercus Ilex, Olea europaea, Laurus nobilis, Pinus Pinea, Cupressus sempervirens; GREECE to PERSIA and AFGHANISTAN: Pinus brutia; ASIA MINOR: Cedrus Libani; SOUTHWESTERN AUSTRALIA: Eucalyptus and Acacia; PACIFIC COAST OF SOUTHERN CALIFORNIA: Libocedrus decurrens, Chamaecyparis Lawsoniana, Cupressus macrocarpa, Pinus sabiniana, Sequoia sempervirens.

2. *The regions of heaviest rain in spring and early summer and the beginning of winter, with drouths in late summer.*—Included in this group are the greater parts of Spain, France, Switzerland, and Austria. The annual rainfall varies in these countries from 60 to over 130^{cm}. It will suffice to give only one or two examples from the many that could be given: Larix europaea, Fagus sylvatica, Quercus Suber, Pinus pyrenaica, Abies Pinsapo.

3. *The regions where all the months of the year are rainy or snowy.*—Included in this class are northern Europe, parts of Siberia and the

extreme north of Japan, North America on the east from Hudson Bay throughout the Alleghanies and on the west as far south as British Columbia. The range of latitude is from 30° northward; and the annual rainfall is 60–200^{cm}. EUROPE: Picea excelsa, Pinus sylvestris; SIBERIA, AMOOR REGION, and NORTHERN JAPAN: Abies firma, Cryptomeria japonica; WEST COAST OF AMERICA: Chamaecyparis nutkaensis; ALLEGHANY REGION: Pinus Strobus, Liriodendron tulipifera, Prunus serotina, Robinia pseudacacia, Celtis occidentalis, Tilia heterophylla, Gleditschia triacantha, Quercus nigra.

4. *The regions of winter rain or snow and heavy summer rains.*—Countries included in this group are British Columbia, Central Japan, and parts of Chile. The range of latitude is 40°–50°, and the annual rainfall is 130 to over 200^{cm}. Examples of these regions are as follows: BRITISH COLUMBIA: Chamaecyparis nutkaensis; CHILE: Araucaria imbricata; CENTRAL JAPAN: Chamaecyparis pisifera, Torreya nucifera.

5. *All the months of the year rainy, the most in winter, but no month without fifteen rainy days.*—The southern part of New Zealand is the only region where this condition holds. No trees of the garden are surely from this region, unless possibly a Dacrydium sp.

6. *All the months of the year rainless, at least with less than six days of rain.*—Under this group come the deserts of the Sahara, central Asia, central Australia, Arizona, and southern California. The latitude range is 20°–50°. This region is that of least rain, never more than 60^{cm} falling annually. OASES OF THE SAHARA: Phoenix dactylifera; GOBI: Tamarix articulata; ARIZONA: tree yuccas and agaves.

7. *Regions of the normal rainy season of the tropics and subtropics, with some drouth in winter and spring.*—The countries included are China, Japan, India, the East Indies, New Guinea, eastern Australia, southern Florida, the Mexican plateau, the West Indies, Central America, Peru, Brazil, and Argentine Republic. This region includes the monsoon forests of India and Brazil, where the annual rainfall exceeds 200^{cm}, the latitude ranging from the equator to 40°. The trees selected from the garden to represent this region are as follows: CHINA: Camphora officinalis, Ginkgo biloba, Cephalotaxus Fortunei, Chamaerops excelsa, Livistona chinensis; JAPAN:

magnolias and camellias; INDIA: Pinus excelsa (found also in an isolated area on a height in Greece), Acer oblongum, Corypha australis; NEW GUINEA, AUSTRALIA, and NEW ZEALAND: Araucaria Bidwellii, A. Cunninghamii, Melaleuca styphelioides, Calistemon saligneum alba, Grevillea robusta; SANDWICH ISLANDS: Pritchardia pacifica; BRAZIL and the ARGENTINE: Eugenia Michelii, Araucaria brasiliensis, Prosopis torquata; ANDES, PERU, BOLIVIA: Schinus molle, Phytolacca dioica; MEXICO: Pinus Montezumae, P. patula, Taxodium mucronatum, yuccas and agaves in regions of less rain; WEST INDIES: Cordia martinicensis; FLORIDA and the ADJACENT GULF STATES: Sabal Adansoni, Magnolia grandiflora, Planera aquatica, Liquidambar styraciflua, Torreya taxifolia, Persea Borbonia.

The plants chosen from the large number in the garden to represent the above regions have been selected particularly because they are well known as types of peculiarly significant societies. Another consideration, which is also a limitation, has restricted the examples to certain groups, such as the conifers and palms, because it has been impossible in many other cases to secure data as to the exact climatic conditions under which the trees are found in a natural state. Information of an exact nature in reference to this is most meager, as everyone knows who has consulted floras to find the ranges of species or the habits of plants with regard to environment. No plants were placed in the list which do not seem to be reasonably vigorous, and many of them are growing most vigorously, as will be seen by the following measurements of circumference taken 30^{cm} from the ground: *Pinus excelsa* 297^{cm}, *Camphora officinalis* 278^{cm} (spread of horizontal branches 12^{m}), *Taxodium mucronatum* 258^{cm}, *Sequoia sempervirens* 239^{cm}, *Cedrus Libani* 227^{cm}, *Araucaria Bidwellii* 195^{cm}, *Ginkgo biloba* 191^{cm}, *Chamaecyparis Lawsoniana* 172^{cm}.

The classification shows that the garden represents plants from 61° north latitude to 48° south latitude. Countries are represented with an annual rainfall of 20 to more than 220^{cm}. There are plants from the high mountains, the Canary pine growing at 2000^{m}; *Pinus excelsa* has a range on the Himalayas of 1800 to 3200^{m}; *Taxodium mucronatum* grows on the highlands of Mexico from 1600 to 2300^{m}; and *Pinus Montezumae* from 2500 to 4400^{m} on Orizaba. There are

plants that thrive in swamps and those that grow in rocky or sandy places. Few regions of the whole earth have not here their representatives.

Still more impressive than these plain facts is a walk in the garden itself in early spring, when the great variety of foliage shows itself to perfection. There is a yellow-green just appearing in the deciduous oaks and maples in the midst of the jungle of tropical evergreen trees with their glossy dark green foliage, and in sharp contrast to both are the gray phyllodial leaves of the Australian wattles, and such plants as *Colletia cruciata*, or the thin gray foliage of the lofty melaleucas and eucalyptus trees. Tree yuccas and tall dracaenas thrust their swordlike leaves through the soft sprays of the conifers. The date palms grow here vigorously and sometimes show a curious adornment of climbing ivies, while northern ferns and blossoming herbs grow in the axils of their fallen leaves. One such palm on close observation showed a score of young seedling maples that had taken root on the trunk of the tree, and had already passed their first summer successfully. Beside the maples, there were on the same tree trunk raspberries, grasses, geraniums, *Cotyledon umbilicus*, fumitory, masterwort, and perennial ferns, forming a most friendly and thriving community.

On superficial view of the trees there seems little variation from normal habit, but there is one tendency so strongly developed here that it seems to be climatic. Many trees develop root-shoots and sprouts from the old wood of the trunks. This is conspicuous in the conifers and palms, where it is certainly an exception to the usual habit of the groups. *Chamaecyparis Lawsoniana* has, besides the main trunk, four prominent ones given off just at the ground line, and they are conspicuously large and well-developed, the main trunk being 172^{cm} in circumference, and the others 56, 45, 40, and 40^{cm}.

Araucaria Cunninghamia has four bushy shoots about 90^{cm} from the base of the trunk. Some specimens of *Pinus canariensis* are clothed to the ground with filmy shoots, recalling the habit of many American elms (*fig. 1*). No other pine with which I am familiar has this habit except *P. rigida*, which frequently exhibits it in regions subject to forest fires.

One specimen of *Cryptomeria japonica* has a remarkable habit

of producing branches some distance from the ground which bend down, and when they meet the soil broaden out and root, throwing up erect stems which become independent trees. The tree is 110^{cm} in circumference and has given rise to six such independent growths, one 65^{cm} in circumference; the others 45, 30, 27.5, 12.5, and

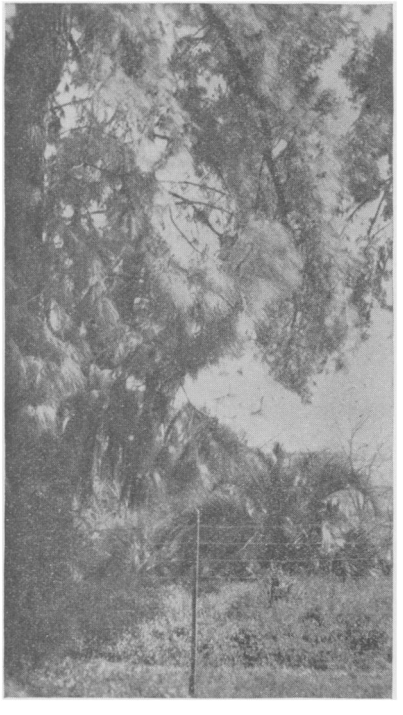

FIG. 1.—*Pinus canariensis:* trunk clothed to the ground with shoots.

FIG. 2.—*Cryptomeria japonica*, showing one of five daughter trees from suckers; two suckers in view.

12.5^{cm}, all 30^{cm} from the ground. The highest of such rooting branches is given off from the trunk 60^{cm} above its base. It is 8.75^{cm} in circumference until it touches the ground, where it flattens and broadens to 15^{cm} in surface view, and creeps some distance from the trunk before rising into the erect shoot. *Fig. 2* shows only one of the daughter trees and two of the suckers.

Several specimens of *Phoenix dactylifera* in the garden produce

leafy shoots in the axils of the old leaves near the base of the trunk, and even some distance from the ground. A very remarkable case of this kind is shown in *fig. 3*, a photograph of a palm growing in a private garden in Naples. Twenty leafy shoots were counted on one side of the trunk alone. The trunk just above the soil measures

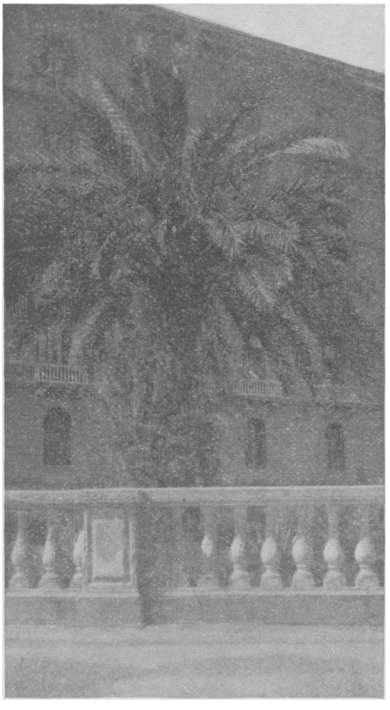

FIG. 3.—*Phoenix dactylifera*, with leafy shoots in the axils of old leaves.

FIG. 4.—*Phoenix dactylifera;* companion tree to that shown in *fig. 3*, whose leaves show in the upper foreground.

257^{cm} in circumference, but these abnormal growths so increase its size at a height of 130^{cm} that it measures 500^{cm}. In this tree and on the others in the botanical garden roots had arisen from the base of these shoots, but after growing a few centimeters they had died. *Fig. 4* shows the companion tree to the date palm of *fig. 3*, which has followed its natural habit. The branching one has not attained the height of the other, but is well developed in every other way.

Chamaerops humilis, the low native palm of the Mediterranean coasts, grows here into a thick bushy tangle from the development of an immense number of underground shoots. This is not an uncommon habit of the plant when growing wild in northern Africa. *Phytolacca dioica* has a curious flat table-like formation of its main roots or of the lower stem just above the ground line, and from this spring a great number of slender vigorous shoots.

The trees of the garden are not of great age, for the garden itself in its present foundation is not very old. Although as early as 1662 there was here a pharmaceutical garden connected with one of the church hospitals, in its present state it was founded in 1809 under the auspices of the Bourbon rulers. Its first director was MICHELE TENORE, who held the position for fifty years. He was succeeded by GUGLIELMO CASPARRI (1861–1866) and GIUSEPPE ANTONIO PASQUALE (1866–1867). In 1893 FREDIRIGO DELPINO, formerly in Genoa and Bologna, became its director, and he still holds the position. TENORE in his long term of fifty years put in train the plans which have been largely followed since. The important large trees now in the garden are included in a catalogue published in 1867 by PASQUALE. In many cases he gives the heights of the tallest trees, and from his figures we can judge that the growth since that time has been strong and normal. With a few exceptions the trees are probably none of them much older than one hundred years. A few of them have been broken by tempests and one or two are stag-headed, but most of them show no signs of abnormal growth. They are not well pruned, but in a natural woodland condition that is most interesting.

It is a remarkable collection when one considers how little care has been given it. One marvels at the friendliness of the climate which has proved congenial to so many strangers. In our own country southern California has a somewhat similar type of native vegetation and somewhat similar climatic conditions, but even there it would hardly be safe to leave such a collection of trees to themselves. One feature of importance is the great fertility of the soil in this region, which has been under the influence of civilization for three thousand years, and probably a good part of that time under cultivation, yet it still yields several harvests a year.

Such a climate as this would be an ideal one in which to establish an experimental garden, with the study of variation in structure in special view. The garden already contains valuable material for research. Naples has proved to be a splendid situation for the Marine Biological Laboratory. There is a place here also for a great botanical station for the study of plants from all the world. The botanists have left the ecology of this region almost untouched until lately, and now Professor J. Y. BERGEN is working on the plants of the Solfatara. This pioneer work should indicate the possibilities of this region as a place where the American botanists might establish a station which would do for botany what the German zoologists have done for zoology.

STAZIONE ZOOLOGICA,
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